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Comparison of Productivity and Cost of Four Balanced Harvest Systems

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Background

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- Australia has ~900,000ha of eucalypt plantations, most of which are short rotation (~10 years) *Eucalyptus globulus* plantations producing export woodchips

- Four main harvest systems are used to harvest *Eucalyptus globulus* plantations
  - Cut-to-length at the stump
  - Cut-to-length at roadside
  - Infield chipping with a debarker/delimber/chipper
  - Infield chipping with a separate flail and chipper

- A research trial was conducted to compare the harvest systems in terms of:
  - Productivity
  - Costs
  - Other pros and cons

Site location

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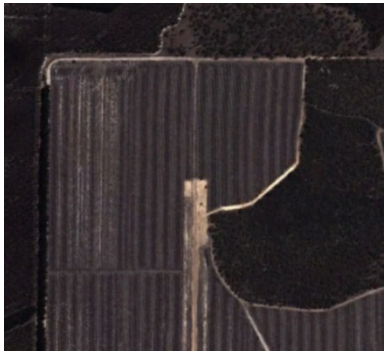

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Stand and site attributes

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Attribute	Value
Age at harvest (years)	10.5
Mean height (m)	17.5
Mean diameter at breast height over bark (DBHOB) (mm)	178
Mean stem weight (GMt)	0.21
Stocking (stems per hectare)	750
Soil	Duplex sandy gravel
Slope (degrees)	<5

Methodology

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- Each harvest system was studied when harvesting in two non-adjacent three row swathes approximately 12 m by 500 m (total area ~ 6ha)

- Machine productivity was determined using time and motion studies
  - Tree weight was calculated from height and diameter
  - Trees were painted with coloured bands to identify their diameter class
  - Log weight was determined from forwarder grapple scales and truck scales

- Study was conducted over a 9 day period

Advantages/disadvantages of study approach

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Advantages

- Harvest systems are compared under the same site, weather and stand conditions
- Results are obtained rapidly

Disadvantages

- Systems may be unbalanced and have unrealistic utilization rates
- Operator differences
- Machine performance differences between machines of the same type
- Generalising results to other areas

Balancing

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- Harvest systems as tested were not balanced, i.e. shift-level machine productivities within a harvest system were not equal.
- Balancing was mainly done by adjusting machine utilisation rates. Where possible, utilisation rates were kept between 60–80%
- In several harvest systems, additional machines were added to achieve balance

Harvest systems – machine numbers

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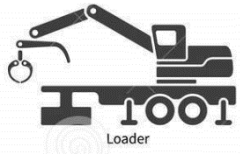
Cut to length at the stump

x3

x2

Cut to length at roadside

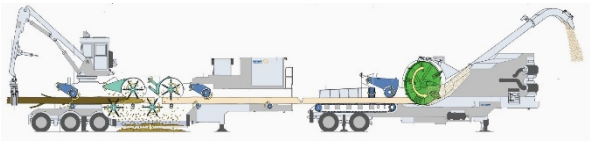
x2



Infield chip with DDC

Infield chip with separate flail & chipper

x2



Machine utilization rates (%) & productivity (GMt/PMH$_0$)

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Cut to length at the stump

69%

16

74%

31

Cut to length at roadside

50%

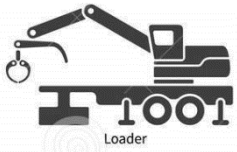
87

73%

59

59%

24



65%

67

Infield chip with DDC

48%

62

76%

39

66%

45

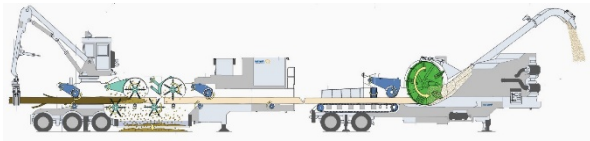
Infield chip with separate flail & chipper

42%

97

70%

29



70%

58

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Results

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Harvest system	Productivity (GMt/shift)	Harvest system cost (A$/GMt)
Cut to length at the stump	320	$34
Cut to length at roadside	431	$31
Infield chip with DDC	296	$29
Infield chip with separate flail & chipper	406	$27

Harvest system pros and cons

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- Cut to length at the stump

Pros	Cons
Highly flexible • Can add/subtract machines • Can be used in sawlog operations	Most expensive system
Logging residue distributed over site	Requires static chipper
Low machinery impact on site	
Cold deck – logs can be stored at roadside when trucks are not available	
Minimum crew size for a harvest system	

Harvest system pros and cons

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- Cut to length at roadside

Pros	Cons
Highly flexible • Can add/subtract machines • Can be used in sawlog operations	More expensive than infield chipping systems
Logging residue left at roadside	Logging residue left at roadside
Cold deck – logs can be stored at roadside when trucks are not available	Higher machinery impact on site
	Requires static chipper

Harvest system pros and cons

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- Infield chipping systems

Pros	Cons
Cheaper than systems producing logs	Relatively inflexible due to the chipper cost
Logging residue redistributed on site by the skidder	Hot deck. Chipper only operates when trucks are available
Logging residue can be left at roadside	Higher machinery impact on the site

Conclusions

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- Infield chipping systems were:
  - Cheapest of the systems tested
  - Least flexible
- Cut-to-length harvest systems were:
  - Most expensive of the systems tested
  - Most flexible

(Note that these findings only apply for the study conditions)

Published papers

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- Strandgard, M., Mitchell, R., Wiedemann, J., 2019: Comparison of Productivity, Cost and Chip Quality of Four Balanced Harvest Systems Operating in a Eucalyptus globulus Plantation in Western Australia. Croatian Journal of Forest Engineering 40 (1), 39-48.

- Ghaffariyan, M., Brown, M., 2013: Selecting the efficient harvesting method using multiple-criteria analysis: A case study in south-west Western Australia. Journal of Forest Science 59(12): 479-486.
- Ghaffariyan, M.R., Brown, M., Spinelli, R., 2013: Evaluating Efficiency, Chip Quality and Harvesting Residues of a Chipping Operation with Flail and Chipper in Western Australia. Croatian Journal of Forest Engineering 34(2): 189–199.

Thank-you!

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